



Growth and Yield of Sweet Pepper as Influence by Different Growth Media

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ABSTRACT

Loss of organic matter and related loss of soil microbial diversity and activity, as a result of intensive agriculture has contributed to an increase in soil borne plant diseases. Sweet pepper is highly susceptible to many soil borne diseases such as damping-off, root rots and wilts. In view of this, the study was conducted to assess the influence of different growth media on sweet pepper in terms of growth, yield and incidence of diseases. Materials used include: Seeds of two varieties of sweet pepper (Yolo wonder and California Wonder), rice husk, coconut hull, sawdust, groundnut hull, sugarcane bagasse, top soil and well cured cow dung. The Soilless media were prepared by mixing it with cow dung in a ratio of 20:1, whilst the cow dung was applied to the top soil at a rate of 100 kg N/ha. The experiment was a two by six (2*6) factorial experiment with twelve (12) treatments replicated three (3) times resulting in a total of thirty six (36) treatments laid out in Complete Randomised Design (CRD). Parameters measured include; plant height, number of leaves per plants, number of fruits per plant, fruit length, fruit diameter and incidence of root rot and wilt diseases. The results on plant heights at various weeks after transplanting showed that, all the soilless media generally, produced plants with significantly higher height at ($p < 0.05$) than the top soil. The results also showed that, the soilless media had superior number of leaves and fruits produced per plant, fruit length and diameter to that of the top soil. There were no incidence of root rot and wilt diseases in the soilless media but the top soil had two incidence of wilt disease. The results reveals that, cultivation of sweet pepper in soilless medium can give you better growth and yield and can also reduce the occurrence of soil borne diseases like root rot and wilt in sweet pepper. Therefore, cultivation of sweet pepper in soilless medium should be encourage to reduce the occurrence of soil borne diseases in other to enhance growth and yield in sweet pepper.

LIST OF ABBREVIATIONS

RH- Rice Husk

CH- Coconut Hull

SD- Saw dust

GH- Groundnut Hull

SB- Sugarcane Bagasse

TS- Top Soil

WAT- Week After Transplanting

N- Nitrogen

P- Phosphorus

K- Potassium

YW- Yolo Wonder sweet pepper variety

CW- California Wonder sweet pepper variety

RH*: Relative Humidity

NA- Not Available

INTRODUCTION

According to Manrique (1993), sweet pepper (*Capsicum annum* L.) originated from Central and South America where, many species were even utilize before the arrival of Columbus. It is a fruit bearing vegetable which belong to the Solanaceae family with tomato and eggplant (Hadfield, 1993). According to Bosland and Votava (1999), sweet pepper is warm season crop, which thrive better under extended frost-free season, but it performs badly at temperature between 5 and 15°C. Anon. (2000) also reported that, temperature of 20 - 25°C is considered to be the optimum temperature for the crop. Sweet pepper thrives in wide range of soils, but prefers well-drained, sandy loam or loamy soil with good nutrients and water holding capacities (Hatutale, 2010). It does well in soil pH range of 5.5 - 6.8 (Anon., 2000).

According to Diaz-Perez *et al.* (2007), green pepper fruit does not ripe once is harvested unripe. It is used in fresh salads, to add flavours to dishes and for canning (Olivier *et al.*, 1981). In Ghana sweet pepper is used salads, curie, soup and stews. Cultivation of sweet pepper is a sour of employment and income to farmers, distributors and exporters (Lartey *et al.*, 2005). Bell pepper can supply up to 8 percent daily allowance of vitamin A, 180 percent of vitamin C, 2 percent of calcium and 2 percent of iron (Kelly and Boylan, 2009). *Capsicum* pepper are great herbal medicine endowed with natural pharmacological bioactive compounds such as phytochemical, capsaicin, essential oils and a rich combination of organic micronutrients with potential health benefits (Ekwere and Udo, 2018). They are generally rich sources of antioxidants and vitamin C (Mateljan, 2018). According to Howard *et al.* (1994), pepper is a major source of natural colour and antioxidants compounds used in food preservation.

Loss of organic matter and related loss of soil microbial diversity and activity as a result of intensive agriculture has contributed to an increase in soil borne plant diseases (Campbell, 2006). According to Katan *et al.* (2002), soil borne disease causes considerable crop losses worldwide annually, and management of soil borne diseases has been identified as one of top farm management issues confronting farmers around the world. Sweet pepper is highly susceptible to many diseases such as damping-off, root rots and wilts. Root rot and wilts diseases are caused by soil borne pathogenic fungi and is one of the most serious diseases in crop cultivation worldwide (Abdel-Monaim *et al.*, 2014). In view of this, this study was conducted to assess the impact of different growth media on sweet pepper in terms of growth, yield and incidence of diseases.

MATERIALS AND METHODS

Experimental design

The experiment was conducted in the greenhouse for the College of Agriculture Education, University of Education, Winneba Asante-Manpong campus in the Ashanti region of Ghana from December, 2017 - May, 2018. The experiment was a two by six (2*6) factorial experiment with twelve (12) treatments replicated three (3) times resulting in a total of twenty four (36) treatments laid out in Complete Randomised Design (CRD).

The treatments include: RH- Rice Husk, CH- Coconut Hull, SD- Sawdust, GH- Groundnut Hull, SB- Sugarcane Bagasse, and TS- Top Soil

Characteristics of the experimental soil

The experimental soil was sandy loam (66% sand, 23% silt and 11% clay) in texture, slightly acid in reaction with pH 6.3 in water and with a bulk density of 1.7 Mg/m³. It was moderately fertile, being low in organic carbon (10.2 g/kg) and available nitrogen (0.9 g kg⁻¹), available phosphorus (4.23 mg kg⁻¹) and has CEC (9.14 cmol kg⁻¹).

Table 1. Temperature and relative humidity values in the green house

Months	Mean Temp. Max.	Mean Temp. Min.	Mean RH. Min. %	Mean RH. Max. %
January	39.3	22.07	48.92	90
February	35.45	18.69	52.08	84
March	35.84	16.69	52.7	84
April	42.13	29.69	54.69	83

RH*: relative humidity

Preparation of soil less media and plant culture

Each of the organic waste (rice hull, sugar cane bagasse, groundnut hull, sawdust and coconut hull) was mixed with cow dung in a ratio of 20:1 (10 kg organic material: 0.5 kg cow dung) and allowed to decompose for a period of 8 weeks. 2.3 kg of each of the medium was later used to fill 2.5 L bucket. 2.3 kg of the experimental soil was also weighed into 2.5 L bucket and 3.9 g of cow dung applied it. Holes were created at the bottom of the buckets to allow drainage.

Table 2. Percentage N, P, and K in the cow dung

% N	% P	% K
1.8	0.7	1.2

Raising of Nursery

The sweet pepper seedlings were raised at the greenhouse in seed trays of 100 cells per seed tray filled with rice husk biochar (rice husk pyrolysed at 400°C in the absence of oxygen). Two weeks after germination, 19:19:19 foliar fertilizer was applied at a rate of 10 g/L to boost growth.

Transplanting of seedlings

Seedlings were transplanted into pots at 6 weeks after sowing, at 5-6 true leaf stage; transplants were dipped into starter solution to facilitate root formation and early establishment. 75 percent moisture content was maintained in the pots throughout the experiment.

Data were collected on the following parameters: plant height, number of leaves per plants, number of fruits per plant, fruit length, fruit diameter and incidence of diseases.

Statistical Analysis

The data collected were analysed using Genstats (11th edition) and the means separated at Least Significance level of 5%.

RESULTS AND DISCUSSION

Effect of different growth media on plant height of sweet pepper

Among the transplanted seedlings of Yolo Wonder variety, the SD, GH media received seedlings with initial height of 10.4 cm which was the highest, followed by CH (10.4 cm), RH (10.0 cm), TS (9.8 cm) and SB (9.7 cm) and in that order (table 3). The TS, SB media also received seedlings with the highest initial height among the California Wonder seedlings followed by SD, RH, CH and GH in that order. Although, some of the transplanted seedling had higher height than others, the differences were not significant at ($p < 0.05$) table 3. This might probably be that, all the seedlings were transplanted from a single growth medium (biochar).

In comparing the effects of the different growth media on plant height at 2 WAT among the Yolo Wonder

variety, it was seen that, the RH medium recorded significantly higher plant height at ($p < 0.05$) than all the other media (table 3). Although, the plant height of CH was significantly lower than RH, it was also significantly higher at ($p < 0.05$) than SD and TS but it was not significantly different at ($p > 0.05$) from the heights of SB and GH. The plant heights at 2 WAT also indicated that, the TS recorded significantly lower height at ($p < 0.05$) than all the other forms of media (table 3). Similar trend was seen in the plant height among the California Wonder except that, in the California Wonder, the height of plant in the RH medium was not significantly different from CH, GH and SB (table 3). The significantly lower plant height recorded in the SD media might be that, the sawdust comes from wood which has relatively higher lignin content which makes it a bit resistant to degradation, so probably the sawdust might still be under decomposition which could have rendered most of nutrients unavailable for plant uptake. Although cow dung was applied to the top soil (TS), it has low inherent fertility and that might have accounted for the lower plant height observed in it.

The result for plant heights at 4 WAT among the Yolo Wonder variety indicated that, the RH recorded the highest plant height (34.0 cm), which was significantly higher at ($p < 0.05$) than the heights in all the other media table 3. The GH media had the next highest height (32.9 cm) after the RH media and it was significantly higher at ($p < 0.05$) than CH, SB, SD and TS table 3. The SB medium had the next highest height at 4 WAT after RH and GH, followed by SD with the TS recording significantly lower plant heights than all the other media table 3. The GH media recorded the highest plant heights (34.1 cm) among the California Wonder variety, which was significantly higher at ($p < 0.05$) than the heights in all the other media table 3. The RH had plant heights of 32.0 cm which was next to the height of GH and significantly higher at ($p < 0.05$) than the heights of CH, SB, SD and TS. The CH, SB, SD and TS had the heights 31.1 cm, 30.8 cm, 26.7 cm and 23.7 cm respectively, which were significantly higher at ($p < 0.05$) than each other in that order table 3. Generally, the TS had significantly lower heights at ($p < 0.05$) than all the other media.

Results on plant height at 6 WAT among the Yolo Wonder variety shown that, the RH had plants with significantly higher heights at ($p < 0.05$) than all the plants in the other media table 3. The CH had the next higher heights (67.8 cm) which was significantly higher at ($p < 0.05$) than the heights of plants in GH, SD, SB and TS. The SD and SB had plant height of 56.8 cm apiece which was significantly higher at ($p < 0.05$) than TS table 3. Similar trend was seen among the California Wonder variety except that, within the California Wonder variety, the height of plants within the SB medium was significantly higher at ($p < 0.05$) than SD table 3.

Table 3: Effect of the different media on plant height

Medium	Plant Height (cm)							
	Initial height		2 WAT		4 WAT		6 WAT	
	YW	CW	YW	CW	YW	CW	YW	CW
RH	10.0	9.9	17.9	17.1	34.0	32.0	78.0	71.8
CH	10.4	9.8	16.5	15.9	32.0	31.1	67.8	66.1
SD	10.4	10.2	14.9	13.8	26.5	26.7	56.3	52.8
GH	10.1	9.3	16.2	15.3	32.9	34.1	61.9	60.5
SB	9.7	10.3	15.6	15.8	31.6	30.8	56.8	57.0
TS	9.8	10.3	13.8	12.6	22.1	23.7	53.4	50.0
LSD	1.4		1.3		1.67		5.27	

Effect of the different growth media on leaf number in sweet pepper

The initial number of leaves per plant on the Yolo Wonder seedlings transplanted into the RH, CH and SD media were significantly fewer at ($p < 0.05$) than the number of leaves on the seedlings for GH, SB, and TS media (table 4). The California Wonder seedlings transplanted into the RH, SD and TS media had equal number of leaves (7) which was significantly lower at ($p < 0.05$) than the number on seedlings for SB medium. But the number of leaves on seedlings for RH, SD, GH and TS media were all significantly higher at ($p < 0.05$) than that of the seedling for CH medium (table 4).

In comparing the number of leaves on the Yolo Wonder variety within the various media at 2 WAT. It was seen that, the RH medium had significantly higher number of leaves at ($p < 0.05$) than that of CH, SD, GH and TS, but it was not significantly different at ($p > 0.05$) from SB medium. The number of leaves on plants within the CH and SB were not significantly different at ($p > 0.05$). But they were all significantly higher at ($p < 0.05$) than that of SD and TS (table 4). Among the California Wonder variety the RH medium had the highest number of leaves (12) which was significantly higher at ($p < 0.05$) than all the plants in the other media except that of GH (table 4). The number of leaves on sweet pepper plants within the CH, SB TS and GH were not significantly different at ($p > 0.05$) from each other (table 4). The significant differences between the number of leaves on the sweet pepper within the RH and other media, might be that the rice husk due to its relatively lower lignin

content could have decomposed faster than the other media, making the nutrients in it available for uptake.

The results for number of leaves per plant on 4 WAT among the Yolo Wonder variety indicated that, the RH medium had the highest number of leaves (20) per plant. Which was significantly higher at ($p < 0.05$) than the number of leaves per plant in all the other media except GH (table 4). The GH medium had the next highest number of leaves after the RH and this was also significantly higher at ($p < 0.05$) than CH, SD and TS (table 4). Among the California Wonder variety, the RH and CH had highest number of leaves per plant and it was significantly higher at ($p < 0.05$) than TS, SD and GH but they were not different at ($p > 0.05$) table 4. Generally all the media recorded higher number of leaves per plant than TS and this could be attributed to low inherent fertility of the soil.

The results for the number of leaves per plant on 6 WAT among the Yolo Wonder variety indicated that, RH CH and GH were not significantly different at ($p < 0.05$), but were significantly higher than TS, SB and SD table 4. Within the California Wonder variety the RH recorded 71 leaves per plant which was also significantly higher at ($p < 0.05$) than all the other media (table 4). The CH medium recorded the next higher number of leaves per plant after RH and this was significantly higher at ($p < 0.05$) than the number of leaves per plant observed in SD, GH, SB and TS (table 4). The GH medium had the third higher number of leaves per plant than SB, SD and TS. The TS had 50 leaves per plant which was significantly lower than all the other media (table 4).

Table 4: Effect of the different growth media on leaf number/plant in sweet pepper

Leave number								
Medium	Initial		2 WAT		4 WAT		6 WAT	
	YW	CW	YW	CW	YW	CW	YW	CW
RH	7	7	13	12	20	19	49	45
CH	7	6	11	10	17	19	50	49
SD	7	7	9	10	15	15	36	42
GH	8	7	10	11	19	17	47	49
SB	8	8	12	10	18	18	44	43
TS	8	7	9	10	15	14	30	33
LSD	0.97		1.34		2.02		6.7	

Effects of different media on number of fruit, fruit length and diameter of sweet pepper

At harvest, the result on number of fruit per plant among the Yolo Wonder variety indicated that, the RH and GH media recorded the highest number of fruit per plant (10) followed by CH and SB media (table 5). The SD medium had 8 fruits per plant which was the third highest number of fruits per plant than the TS (table 5). The RH, CH, GH and SB media had 11 fruits each per plant, which was the highest among the California Wonder variety. The SD had 9 fruits per plants which was the second highest number of fruits per plants after RH, CH, GH and SB, with the TS recording 7 fruits per plants which was the lowest among the California Wonder variety (table 5). Generally the TS recorded the lowest number of fruit per plants in both varieties and this can be due to the low inherent fertility of the experimental soil.

In comparing the fruits length of Yolo Wonder variety at harvest, it revealed that although, the SB

medium recorded the second highest number of fruits per plant, it had the longest fruits length (6.4 cm) table 5. The RH, CH, SD and GH had fruits lengths of 6.3, 6.1, 6.0 and 5.9 cm respectively, with the TS recording the shortest fruit length of 5.0 cm (table 5). The RH had the longest fruit length of 6.6 cm which was the longest fruit length among the California Wonder variety, followed by SD with fruit length of 6.5 cm (table 5). The GH and CH had fruits length of 6.1 cm which was third longest fruit length, whilst the TS had the shortest fruit length of 5.1 cm (table 5).

The RH and TS media recorded the shortest fruits diameter (1.9 cm) among the Yolo Wonder variety. The SB and SD had the longest fruit diameter (2.3 cm) followed by CH (2.1 cm) and GH (2.0 cm) in that order table 5. The RH and SD had the longest fruit diameter (2.3 cm) among the California Wonder variety, followed by CH and SB (2.2 cm). The GH had the third longest fruit diameter (2.1 cm) with the TS recording the shortest fruit diameter (table 5).

Table 5: Effects of different media on number of fruit, fruit length and diameter of sweet pepper

Medium	fruit /plant		fruit length (cm)		fruit diameter (cm)	
	YW	CW	YW	CW	YW	CW
RH	10	11	6.3	6.6	1.9	2.3
CH	9	11	6.1	6.1	2.1	2.2
SD	8	9	6.0	6.5	2.3	2.3
GH	10	11	5.9	6.1	2.0	2.1
SB	9	11	6.4	5.8	2.3	2.2
TS	6	7	5.0	5.1	1.9	1.7
LSD	2.35		0.92		0.44	

Incidence of diseases in the various media

None of the varieties recorded any incidence of root rot disease but there were two incidence of wilt disease in the TS within the California Wonder variety

(table 6). This might probably be that the TS was already harbouring the pathogen for the disease (wilt).

Table 6. Incidence of diseases in the various media

medium	Root rot		Wilt	
	YW	CW	YW	CW
RH	NA	NA	NA	NA
CH	NA	NA	NA	NA
SD	NA	NA	NA	NA
GH	NA	NA	NA	NA
SB	NA	NA	NA	NA
TS	NA	NA	NA	2

CONCLUSION

The results from the experiment showed that, soilless medium can promote growth and yield in sweet pepper than top soil. The results also indicated that, soilless medium has no or lower incidence of soil borne diseases as compared to top soil. Therefore it can be concluded that, soilless medium is a better alternative for sweet pepper cultivation.

AUTHOR'S CONTRIBUTION

The project was executed with the financial contribution from both authors. The preparation of the soilless media, potting, nursing of seeds and transplanting of seedlings were done by both authors (Michael Egyir and Bernard Awuku). Data collection, introduction and review of relevant literature was done by Bernard Awuku whilst Michael Egyir analysed and discussed the results based on the data collected and writing of other aspects of the manuscript. At the end both authors put the entire work together and read through it before submission for publication.

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